TECHNICAL MEMORANDUM

FOR THE

PHASE I FIELD INVESTIGATION

AT

THE SELMER COMPANY
500 INDUSTRIAL PARKWAY
ELKHART, INDIANA

Prepared for

NORTH AMERICAN PHILIPS CORPORATION
THE SELMER COMPANY
AND
MACMILLAN, INC.

Prepared by

WW ENGINEERING & SCIENCE
5555 GLENWOOD HILLS PARKWAY
GRAND RAPIDS, MICHIGAN 49588-0874

JANUARY 1994

PROJECT 22334

WW Engineering & Science
A Summit Company

E)
1/94

January 20, 1994

WW Engineering & Science
A Summit Company

Mr. Ken Theison
On-Scene Coordinator
U.S. EPA, Region V
77 W. Jackson Boulevard HSE-5J
Chicago, Illinois 60604

RE: SELMER SITE, ELKHART, INDIANA (CIVIL ACTION NO. S89-00348)
PHASE I FIELD INVESTIGATION TECHNICAL MEMORANDUM

Dear Ken:

Enclosed is a copy of the Technical Memorandum for the Phase I Field Investigation at the Selmer site in Elkhart, Indiana. This submission is one week ahead of the scheduled submission date as specified in the project schedule included in the approved Work Plan. As we have discussed on the telephone, it will be advantageous to implement Phase II prior to spring because of site access difficulties that will be experienced when the ground is thawed and vegetation is in bloom. We are prepared to implement the Phase II work as soon as we receive your approval of the Phase I Technical Memorandum.

By copy of this letter, copies of the technical memorandum are submitted to those indicated, as specified in Section XXII of the consent decree.

If you have any questions, please contact me at (616) 942-9600.

Sincerely,

WW ENGINEERING & SCIENCE
Environmental Services

Scott Dennis

Scott T. Dennis, C.P.G.
Senior Hydrogeologist

cc: Frank Bentkover-Chief, Environmental Enforcement Section, U.S. Dept. of Justice
Chief, Emergency Response Branch, HSE-5J, U.S. EPA-Region V
Thomas Burzycki, The Selmer Company, L.P.
Risa H. Weinstock, North American Philips Corporation
Linda M. Bullen-McDermott, Will & Emery

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Bloomington, IN Chattanooga, TN Columbus, OH Detroit, MI Indianapolis, IN Milwaukee, WI Minneapolis, MN

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JANUARY 1994

PROJECT 22334

Prepared by:

Lauryl A. Lefebvre

Lauryl A. Lefebvre
Project Hydrogeologist

Reviewed by:

Scott T. Dennis

Scott T. Dennis, C.P.G.
Senior Hydrogeologist

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1.0 INTRODUCTION

WW Engineering & Science (WWES) has been jointly retained by North American Philips Corporation, The Selmer Company, L.P., and Macmillan, Inc. to prepare and implement an investigation work plan for The Selmer Company site, hereafter referred to as the "Site," as defined in the Consent Decree in U.S. v. The Selmer Company, L.P., et. al. (Civil Action No. S89-00348). The Site includes the Selmer Company facility, hereinafter referred to as the "facility," and is located at 500 Industrial Parkway in the Eastside Industrial Park in Elkhart, Indiana (see Figure 1). The facility was built in 1965 and has been used exclusively for the manufacturing of brass musical instruments.

WWES prepared a work plan entitled *Work Plan for a Field Investigation at the Selmer Company*, dated October 1992 (Work Plan). This Work Plan was approved by U.S. EPA and incorporated into the referenced Consent Decree. The Work Plan described field investigative activities designed to characterize the soil and ground water conditions at the Site in order to determine the presence or absence of an area(s) of contamination that may have resulted from an alleged historical disposal of trichloroethene (TCE) at the Site. TCE was used during the manufacturing process to degrease and clean metal parts.

The Work Plan was divided into two phases of work. The first phase of investigation (Phase I) consisted of the implementation of a soil gas survey to determine the identity, relative magnitude, and distribution of volatile organic compounds (VOCs) in the soil vapor of the unsaturated zone. The second phase of investigation (Phase II) will consist of the implementation of a drilling and soil and ground water sampling program to characterize the soil stratigraphy, quantify VOCs which may be present in the soil and ground water, and evaluate the distribution of the VOCs.

This technical memorandum presents the results of Phase I of the investigation--soil gas survey--which was implemented during November and December 1993. Based on the results of the soil gas survey which indicated the presence of VOCs in the soil gas, this memorandum also provides recommendations for the soil borings/temporary well locations for the second phase of investigation in accordance with the U.S. EPA-approved Work Plan.

1.1 DESCRIPTION OF FACILITY AND SITE BACKGROUND

The facility consists of 18.45 acres of lightly wooded land and is located in the W1/2 of SE 1/4 of Section 3 of T37N, R5E of Concord Township (Figure 1). The manufacturing plant and associated storage buildings are located in the northern half of the property (see Figure 2). An office building with a parking lot is located at the south end of the facility. Asphalt pavement for parking also exists along the western portion of the facility.

Surface water runoff drains to topographic depressions located east of the manufacturing building and west of the office building. These depressions are wooded and periodically contain standing water. The area east of the manufacturing building was the area of interest in this investigation.

The facility, currently operating under the name "Vincent Bach Company," was constructed in 1965 and has been used exclusively for the manufacture of brass musical instruments. The facility was operated from 1965 to 1970 by C.G. Conn, Ltd. The property was transferred in June 1970 to The Selmer Company. On December 29, 1988, The Selmer Company was sold to Integrated Resources Inc. In late 1993, Integrated Resources sold the business to private investors.

Several additions have been added to the manufacturing plant since its construction in 1965. In 1971, the building was expanded approximately 59,000 square feet north and 12,000 square feet east of the original plant. A storage shed is located east of the northern addition. In 1972, a southern extension of approximately 15,000 square feet was added to the original manufacturing plant.

A narrow strip of asphaltic and/or concrete pavement ranging 20 to 40 feet wide runs along the east side of the manufacturing building. Concrete pavement also extends 185 feet east of the manufacturing building south of the storage shed. To the east and south of the asphaltic and/or concrete pavement, the ground surface is heavily vegetated and decreases in elevation towards the lowland on the east side of the Site. Figure 2 shows the topography in this area, which was the focus of this investigation.

1.2 PETREX TECHNOLOGY

A soil gas survey was performed during Phase I field investigation using the high resolution soil gas technique known as Petrex technology, developed by Northeast Research Institute (NERI) of Farmington, Connecticut. The Petrex method takes advantage of the recent advances in sorbent technology, collection device design, mass spectrometry, and computerized pattern recognition techniques. The collection device design uses passive sampling techniques in which samples are collected from undisturbed soils. Passive soil gas sampling allows an equilibrium to develop between the soil gases and the sorbent, a charcoal device.

The charcoal adsorbent is adhered to two ferromagnetic wires within a glass tube. One wire is used for mass spectrometer (MS) analysis, the other wire is reserved for gas chromatograph/mass spectrometer (GC/MS) analysis, if needed. The passive charcoal devices are buried in shallow soil for a number of days and retrieved for analysis by desorption into the ion source of a MS via Curie-point thermal desorption. Refer to Appendix A for a more detailed account of NERI's standard operating procedures (SOP's) associated with Petrex technology.

2.0 OBJECTIVES AND SCOPE OF WORK

The field investigation was designed to address the allegation of historical disposal of TCE on the east side of the manufacturing facility. The purpose of the Phase I work was to determine the presence or absence and distribution of VOCs, if any, in the soil vapor of the unsaturated zone (soil gas) which may have resulted from the alleged improper historical disposal of TCE east of the manufacturing plant. The specific objectives of the Phase I investigation were as follows:

- to determine the occurrence and relative magnitude of VOCs, if any, in the soil gas;
- to evaluate the distribution of the VOCs, if any;
- to recommend the most appropriate locations for proposed Phase II soil borings/temporary wells, based on the results of the soil gas survey.

The scope of work for Phase I included the application of Petrex passive sampling techniques. Specifically, the scope of work for the investigation included the following tasks:

- establishment and survey of site grid;
- installation of soil gas samplers including time calibration samplers;
- removal and analysis of time calibration samplers;
- calculation of optimal residence time of soil gas samplers;
- removal and analysis of soil gas samplers;
- preparation of isochemical contour maps;
- assessment of the distribution of VOCs; and
- determination of proposed Phase II soil boring/temporary well locations.

3.0 METHODOLOGY

This section summarizes the field and laboratory methodology implemented during the Phase I investigation. All field work was conducted by properly trained personnel in accordance with Occupational Safety and Health Administration (OSHA) guidance and was implemented in accordance with the "Health & Safety Plan" presented in Appendix B of the U.S. EPA-approved Work Plan.

3.1 SURVEY

Prior to the installation of the soil gas samplers, a 400- by 250-foot survey grid was established by WWES' survey personnel based on arbitrary site grid coordinates. The survey established control lines at 50-foot intervals within the grid area (shown on Figures 2 and 3). Soil gas sample locations were located on the control lines at 50-foot intervals throughout the survey grid. Soil gas sample locations were also set at 25-foot intervals in the northwestern portion of the grid area adjacent to the manufacturing plant.

All soil gas sample locations were established at the locations presented in the Work Plan, except as noted below. A representative of the U.S. EPA was present on the Site to oversee WWES' installation of the soil gas samplers. Seven soil gas sample locations were offset from the proposed locations due to the presence of surface water in the lowland area on the southern half of the grid. Soil sample locations SG-45, SG-52, SG-53, SG-60, SG-61, SG-68, and SG-69 were moved from the proposed locations to the edge of the standing water. Additionally, one soil gas sample location (SG-56) was offset 1 foot to the south of the proposed location due to the presence of concrete. These locations were moved to the perimeter of the standing water upon approval of the on-site U.S. EPA representative. In addition, three sample locations (SG-55, SG-63, and SG-71) were offset because of large trees and especially heavy vegetation. The actual locations of all soil gas sample locations are shown on Figure 3.

Several benchmarks were established on the Site to measure ground surface elevations for all soil gas sample locations to the nearest 1/10 of a foot. The benchmarks were measured at the third order accuracy based on the National Geodetic Vertical Datum 1929 (NGVD 29) as established from the City of Elkhart sanitary sewer utility drawing #124.

A topographic contour map was created in the area of the survey grid based on the ground surface elevations of the soil gas sample locations augmented by selected points to further define the topography. Figures 2 and 3 show this topography.

3.2 INSTALLATION OF SOIL GAS SAMPLERS

The soil gas samplers were installed, activated and removed at the Site by WWES field personnel trained in Petrex soil gas procedures. A total of 71 soil gas samplers (SG-1 through SG-71), provided by NERI, were placed in uniform arrays within the 400-foot by 250-foot grid east of the manufacturing plant (Figure 3).

The soil gas samplers were activated in the field by removing the cap and seal and placing them in an inverted position into cored holes at an approximate depth of 12 inches. The boreholes were augered using a specially designed shovel tool. Sample locations within the concrete/pavement areas were cored using a 3-inch diameter bit to accommodate the 1-inch outer diameter (OD) sampler. The boreholes were backfilled with aluminum foil and native soil cuttings, and flagged for easy location. At each sample location, field notes were recorded regarding sample location, type of sampler installed (regular or duplicate), date and time of installation, soil profile, moisture conditions, and type of flagging.

The time calibration samplers were used to assess the loading rate of VOCs onto the Petrex collector wires. The results obtained from the time calibration samplers were used to calculate the total residence time for the survey gas samplers.

3.3 REMOVAL OF TIME CALIBRATION SAMPLERS

Two sets of four time calibration samplers (TC-1 through TC-4) were installed at four soil gas sampler locations (SG-9, SG-13, SG-47, SG-59). One set of time calibration samplers was retrieved on November 5, 1993, three days following installation; the second set of samplers were retrieved on November 9, 1993, seven days following installation. The time calibration samplers were submitted to NERI's laboratory for analysis. Based on these time calibration samplers, the optimal total residence time for the survey samplers was calculated to be approximately 11 days.

3.4 REMOVAL OF SOIL GAS SAMPLERS

All soil gas samplers were removed on November 12, 1993, following a residence time of approximately 11 days. All soil gas samplers were reported in good condition upon removal from the subsurface, with the exception of SG-45. The glass housing of soil gas sampler SG-45 broke upon removal from the subsurface and the element wires were retrieved and placed in a new glass tube; this had no adverse effect on the results from SG-45.

The sampler boreholes were backfilled with native soil cuttings, with the exception of the boreholes located within the pavement area, which were backfilled with quick-setting cement.

3.5 LABORATORY ANALYSIS OF SOIL GAS SAMPLERS

Upon retrieval of the soil gas samplers from the field, the samplers were shipped via overnight carrier on November 15, 1993 to NERI's Lakewood, Colorado laboratory for analysis by Thermal Desorption-Mass Spectrometry (TD-MS).

The analyses were performed by Curie-point desorption directly into the ion source of an interfaced quadrupole MS. During each sample analysis, the desorbed VOCs were analyzed in the mass range of 30 to 240 atomic mass units (amu), if present. The information obtained during the analysis process was stored in the computer as a composite of the VOCs collected at each sample location. The data were downloaded onto a graphics workstation where the information was processed using a variety of chemometric techniques.

3.6 QA/QC PROGRAM

The quality assurance/quality control (QA/QC) plan for the field investigation included specific procedures for field documentation, sample collection, sample packaging and shipment, and laboratory analyses as outlined in the October 1992 field investigation Work Plan. The collection and analyses of duplicate soil gas samplers (one duplicate sample for every 10 samples collected) and travel blanks (2 trip blanks per shipment) were also included in the QA/QC plan.

Eight soil gas samplers (SG-1, SG-10, SG-14, SG-22, SG-43, SG-58, SG-60, and SG-70) installed during the survey were duplicate samplers (Figure 3).[1] The analysis of the duplicate soil gas samplers allowed NERI to slightly increase or decrease the sensitivity of the mass spectrometer by comparison of the extra element wire to the regular sampler element wire, if necessary. Additionally, the analysis of duplicate samplers allowed comparison of element wires with respect to compound identification and intensity.

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1 The duplicate samplers contain three element wires, unlike the regular samplers which contain two element wires.

Two travel blanks (TB-1 and TB-2) were also included as part of the QA/AC plan. The travel blanks consisted of sealed regular soil gas samplers, which were stored with the survey samplers during transport to and from the NERI laboratory.

4.0 RESULTS OF PHASE I FIELD INVESTIGATION

Three VOCs were present in some of the soil gas samplers above normal atmospheric conditions--tetrachloroethene (PCE), trichloroethene (TCE), and trichloroethane (TCA). Identification and relative response of the VOCs were reported to WWES by NERI on December 13, 1993 (NERI's report is in Appendix B). Relative response reported by NERI for each compound has been described as "elevated" or "moderate" relative to the entire data set and has been based on the ion count values (i.c.) observed during sample analyses.[2]

Ion counts are the unit of measure generated by the MS to illustrate the relative intensities associated with each of the reported compounds. These response levels do not represent an actual concentration of the reported compounds. An approximate correlation of the ion counts to actual soil concentrations indicate a relatively low level of PCE, TCE, and TCA in the soil based on historical applications of Petrex technology at other sites. Actual concentrations will be determined in Phase II of this investigation.

To assess the distribution of the PCE, TCE, and TCA in the soil gas, the relative responses of each compound was plotted and contoured. The distribution of these three VOCs are shown in Figures 4, 5, and 6.

4.1 DETECTION AND DISTRIBUTION OF PCE

Elevated responses (relative to this data set) of PCE ($\geq$ 1,000 i.c.) have been detected adjacent to the original manufacturing plant in the northwest corner of the site grid and the central portion of the western half of the site grid (Figure 4). Moderate responses of PCE (100 - 999 i.c.) were noted adjacent to the areas of elevated response and in the northeast (SG-56, SG-57, and SG-64) and southeast corners of the site grid (SB-71). The lateral extent of PCE in the soil gas appears to decrease where the ground surface elevations are lower, towards the wet lowland area.

2 The terms "elevated" and "moderate" are relative only to the data set from the Selmer site and do not in any way reflect a comparison with off-site or background levels.

4.2 DETECTION AND DISTRIBUTION OF TCE

Elevated responses (relative to this data set) of TCE (≥ 2,000 i.c.) have been observed along the western edge of the site grid east of the original manufacturing plant and at the central portion of the northern half of the site grid (SG-50). Moderate responses of TCE (1,000 - 1,999 i.c.) have been detected at generally lower ground surface elevations at the outer edges of the elevated response areas and at the northeast corner of the site grid (SG-64).

4.3 DETECTION AND DISTRIBUTION OF TCA

An elevated response (relative to this data set) of TCA (≥100 i.c.) has been detected at one soil gas sampler location, SG-42, located near the central portion of the site grid. Moderate reposes of TCA (10 - 99 i.c.) have been detected at higher ground surface elevations west of SG-42 and at the northwest corner of the site grid. Sporadic detection of TCA was also observed at the northeast corner (SG-56 and SG-57) and the southeast corner (SG-71) of the site grid.

5.0 CONCLUSIONS AND RECOMMENDATIONS

During November and December 1993, a soil gas survey using Petrex technology was implemented to determine the occurrence, relative magnitude, and distribution of VOCs, if any, at the Site. Three VOCs (PCE, TCE, and TCA) were detected at low ion count levels ranging from non-detect to approximately 4,000 i.c. Elevated responses[3] of the VOCs were detected along the western edge of the site grid along the east side of the manufacturing plant. Moderate responses were detected adjacent to the elevated response areas and in the northeastern and/or southeastern portion of the site grid.

The soil and ground water quality at the Site will be evaluated during the Phase II field investigation which will include sampling of the soil and ground water at the Site. Five soil boring/temporary well areas (SB-1 through SB-5) were tentatively identified in the October 1992 Work Plan (Figure 7). Based on the results of the Phase I field investigation, two of the five proposed locations (SB-1 and SB-5) have been revised as shown on Figure 7. Three of the five proposed soil boring locations (SB-2 through SB-4) have remained within the originally proposed areas.

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3 The terms "elevated" and "moderate" are relative only to the data set from the Selmer site and do not in any way reflect a comparison with off-site or background levels.

The soil borings/temporary wells will be located as described below:

- Soil boring SB-1 will be located south of the initial SB-1 area, adjacent to soil gas sampler location SG-50. This location is within a topographically low area which also displayed an elevated TCE response.

- Soil boring SB-2 will be located in an area of elevated response of TCE, within the originally proposed SB-2 area (between SG-15 and SG-16).

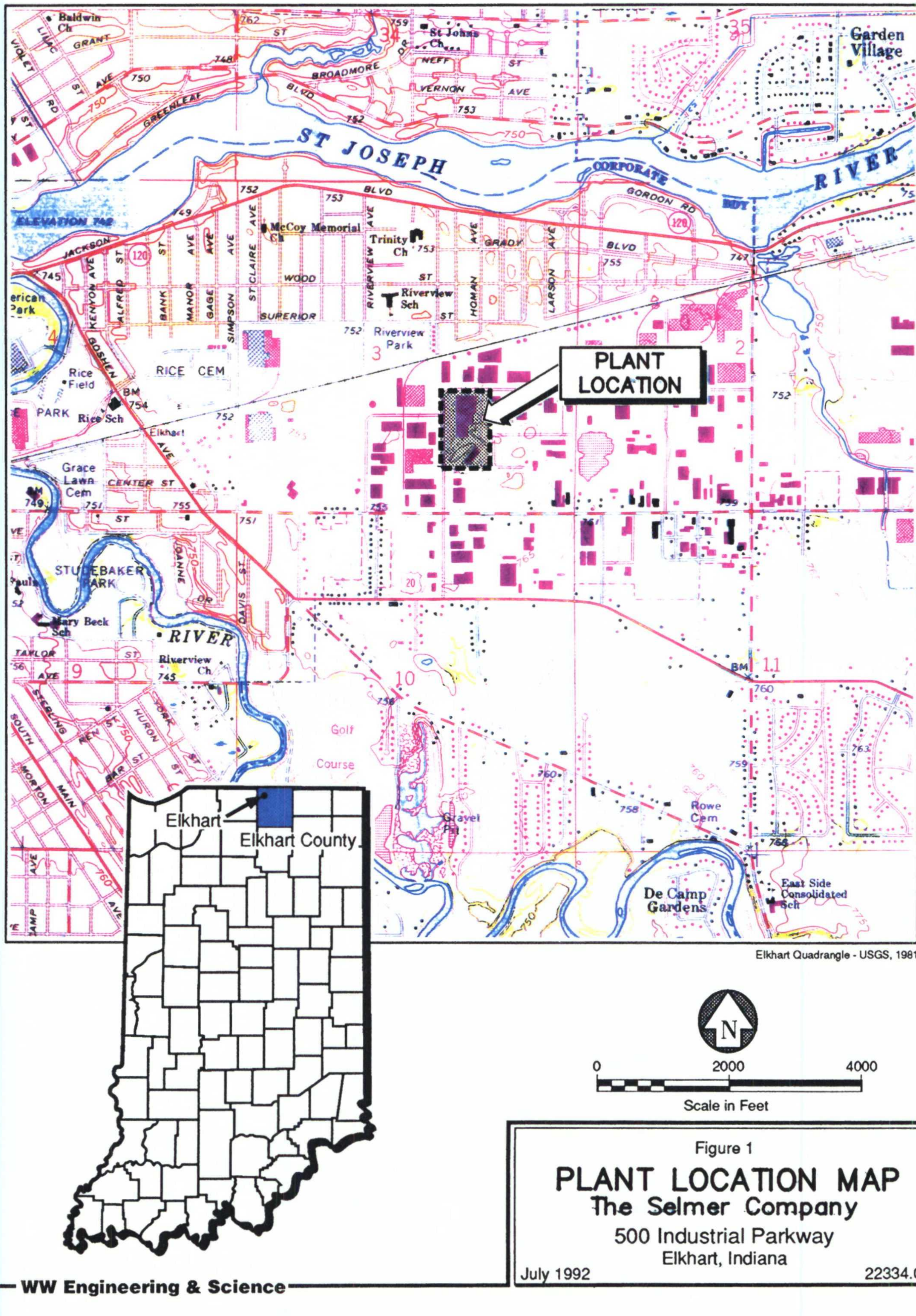
- Soil boring SB-3, with a proposed location adjacent to soil gas sampler location SG-1, also will not deviate from the original proposed area and will be located in an area of elevated TCE and PCE response and moderate TCA response.

- Based on the Phase I results, no VOCs are present in the soil gas above atmospheric conditions in the originally proposed SB-4 area. To confirm there is no impact to soil, soil boring SB-4 will be located within the area, adjacent to soil gas sampler location SG-21.

- Soil boring SB-5 was originally proposed within the southeast portion of the site grid in an area representing background conditions; however, this area is nearly inaccessible due to the presence of heavy vegetation. The proposed soil boring location for SG-5 as shown on Figure 7 has been moved to the northern portion of the site grid adjacent to SG-56. The results of the soil gas survey indicate moderate relative responses of PCE, TCE, and TCA at this location.

All activities will be scheduled and implemented as described in the U.S. EPA-approved Work Plan dated October 1992. As presented in Figure 6 of the Work Plan, the schedule for implementation will begin upon U.S. EPA's approval of this Phase I technical memorandum.

FIGURES



Elkhart Quadrangle - USGS, 1981

Figure 1

PLANT LOCATION MAP

The Selmer Company

500 Industrial Parkway

Elkhart, Indiana

July 1992 22334.00

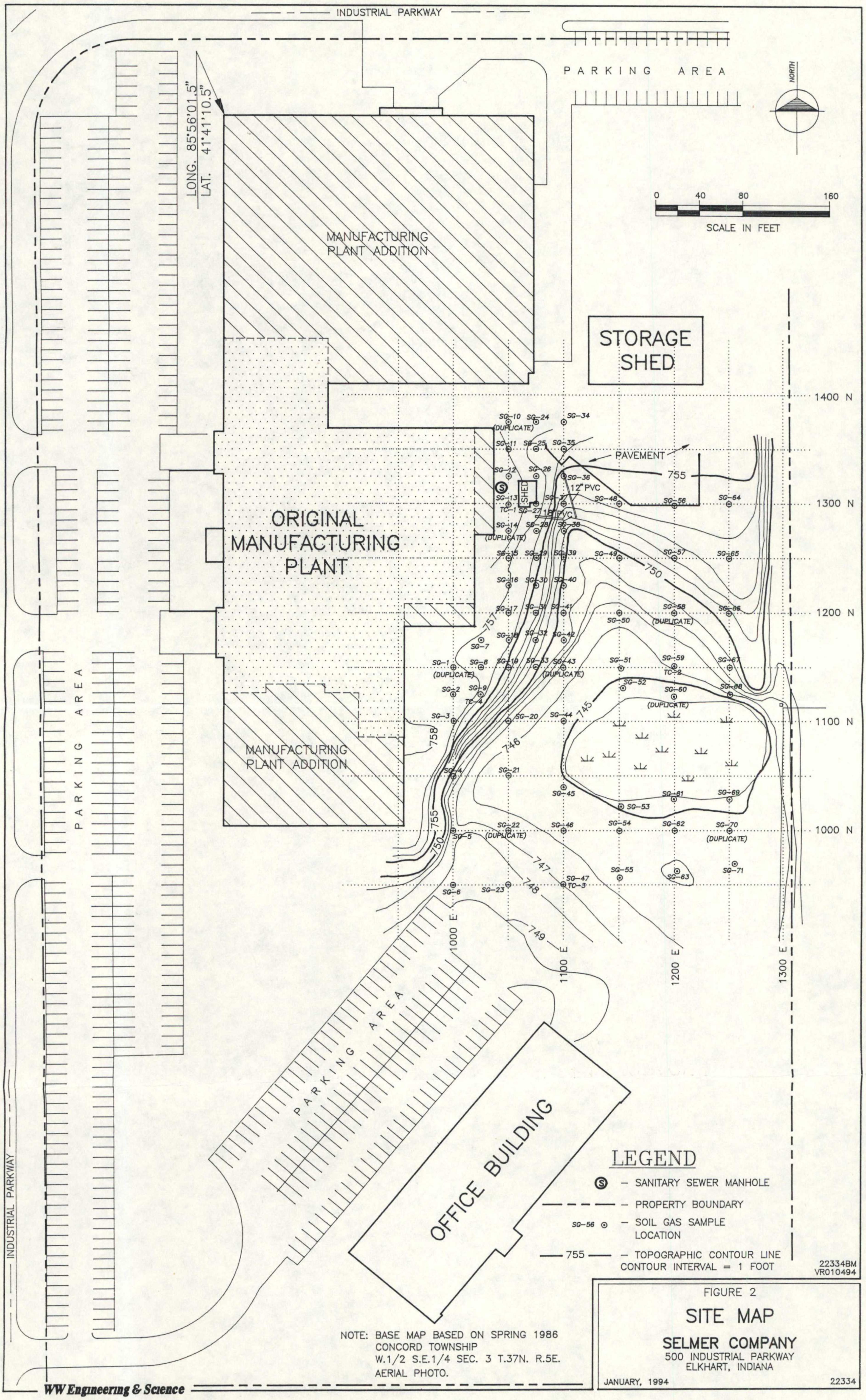


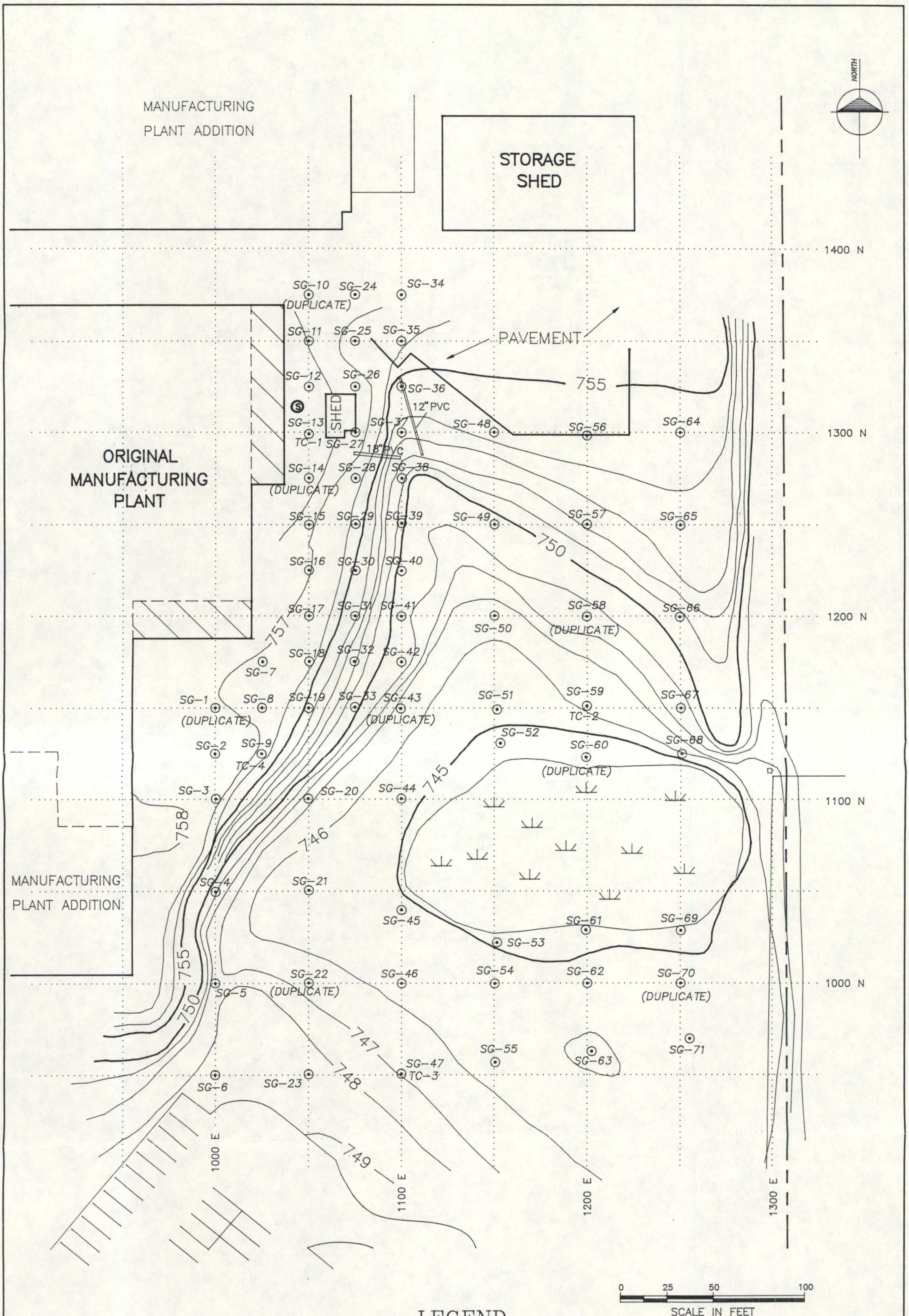
FIGURE 2

SITE MAP

SELMER COMPANY
500 INDUSTRIAL PARKWAY
ELKHART, INDIANA

JANUARY, 1994

22334



22334-SG
VR010494

LEGEND

Ⓢ – SANITARY SEWER MANHOLE

——— – PROPERTY BOUNDARY

SG-55 ⊙ – SOIL GAS SAMPLE LOCATION

— 755 — – TOPOGRAPHIC CONTOUR LINE
CONTOUR INTERVAL = 1 FOOT

NOTE: BASE MAP BASED ON SPRING 1986
CONCORD TOWNSHIP
W.1/2 S.E.1/4 SEC. 3 T.37N. R.5E.
AERIAL PHOTO.

FIGURE 3

SOIL GAS SAMPLER LOCATION MAP

SELMER COMPANY
500 INDUSTRIAL PARKWAY
ELKHART, INDIANA

JANUARY, 1994 22334

WW Engineering & Science

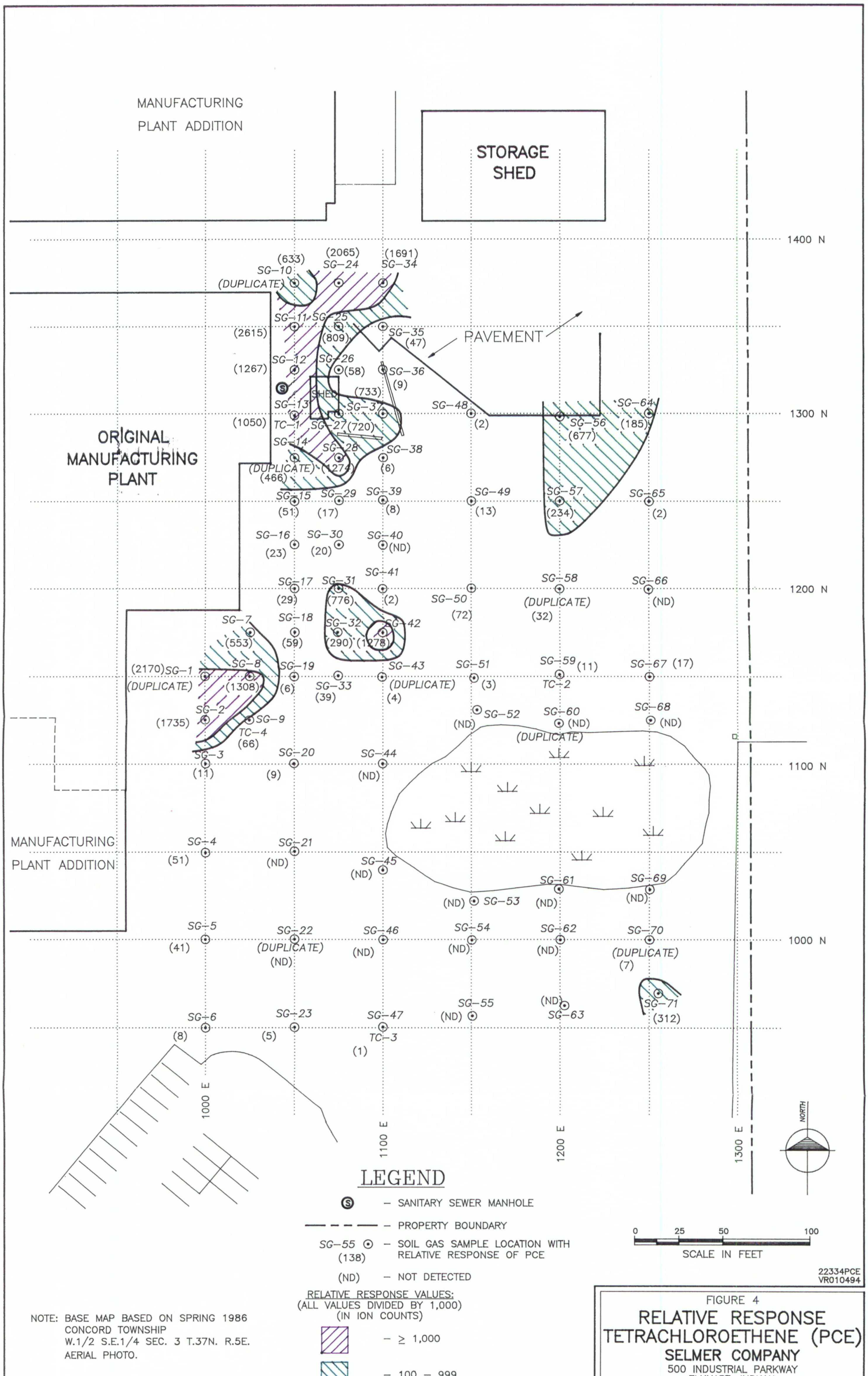
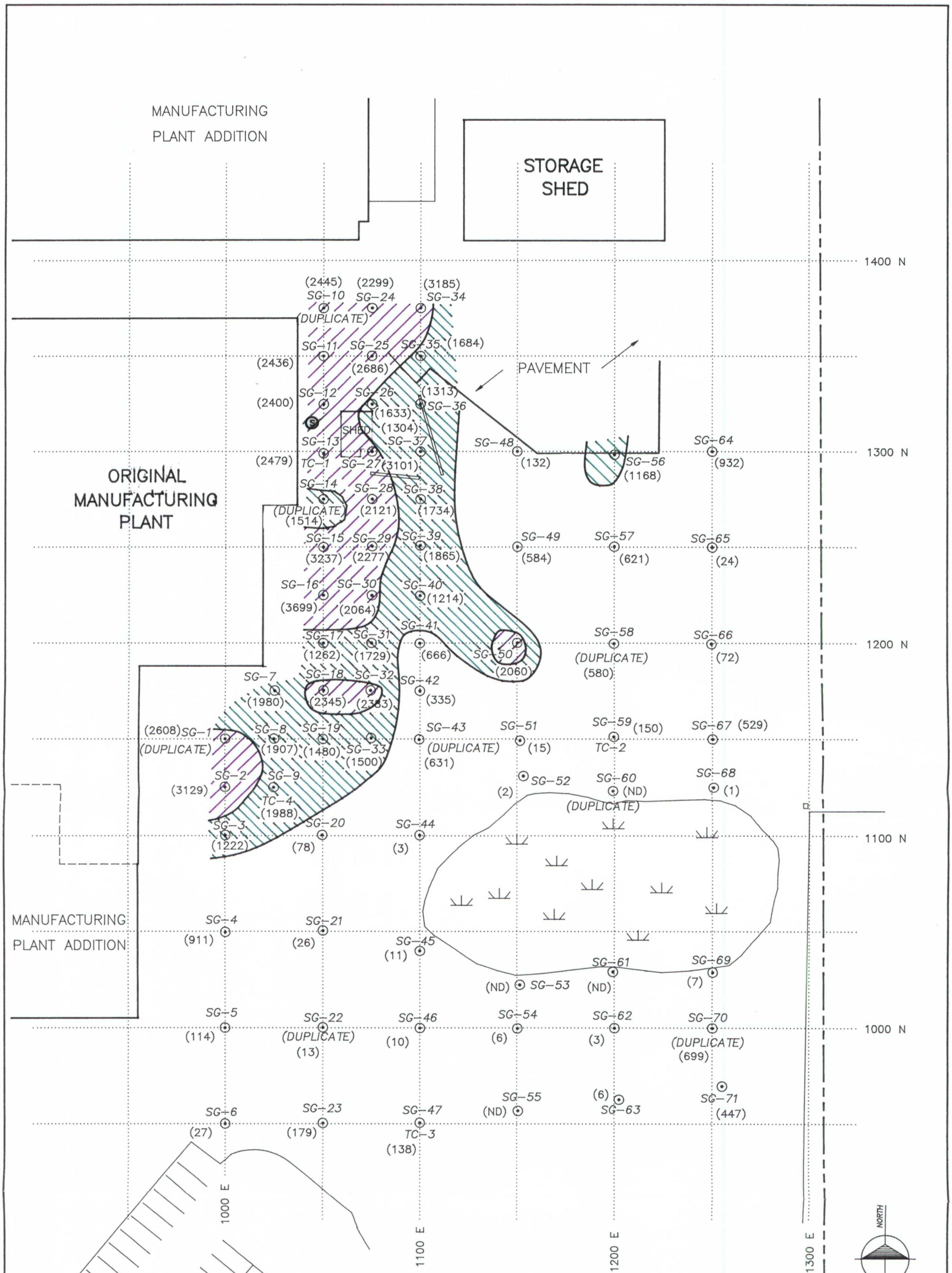


FIGURE 4
RELATIVE RESPONSE
TETRACHLOROETHENE (PCE)
SELMER COMPANY
500 INDUSTRIAL PARKWAY
ELKHART, INDIANA
JANUARY, 1994 22334



LEGEND

Ⓢ – SANITARY SEWER MANHOLE

— — — – PROPERTY BOUNDARY

SG-55 ⊙ (138) – SOIL GAS SAMPLE LOCATION WITH RELATIVE RESPONSE OF TCE

(ND) – NOT DETECTED

RELATIVE RESPONSE VALUES:
(ALL VALUES DIVIDED BY 1,000)
(IN ION COUNTS)

– $\geq$ 2,000

– 1,000 – 1,999

0 25 50 100
SCALE IN FEET

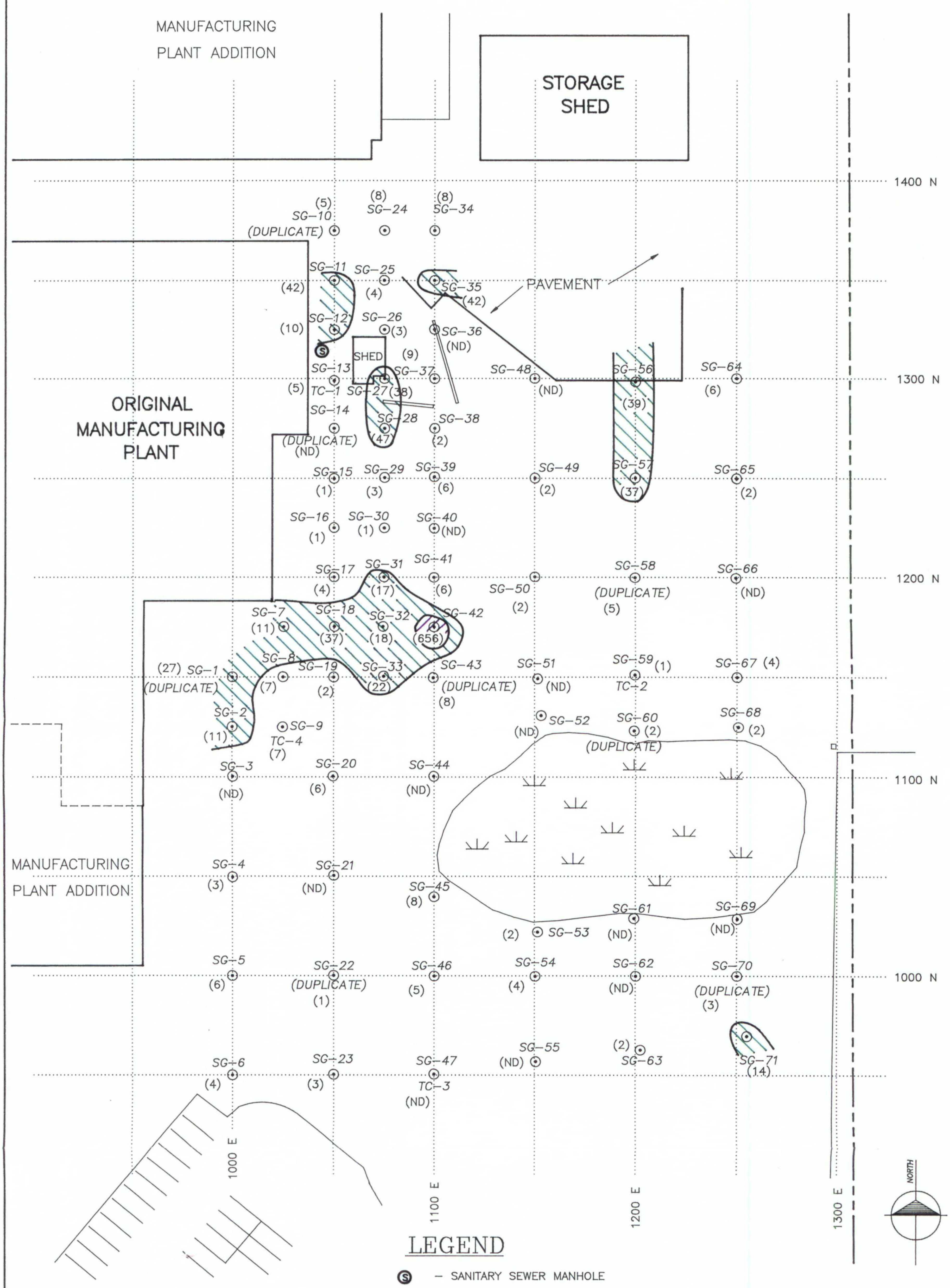
NOTE: BASE MAP BASED ON SPRING 1986 CONCORD TOWNSHIP W.1/2 S.E.1/4 SEC. 3 T.37N. R.5E. AERIAL PHOTO.

22334TCE
VR010494

FIGURE 5
RELATIVE RESPONSE TRICHLOROETHENE (TCE)
SELMER COMPANY
500 INDUSTRIAL PARKWAY
ELKHART, INDIANA

JANUARY, 1994 22334

WW Engineering & Science



LEGEND

- SANITARY SEWER MANHOLE
- PROPERTY BOUNDARY

SG-55 (22) – SOIL GAS SAMPLE LOCATION WITH RELATIVE RESPONSE OF TCA

(ND) – NOT DETECTED

RELATIVE RESPONSE VALUES:
(ALL VALUES DIVIDED BY 1,000)
(IN ION COUNTS)

– ≥ 100

– 10 – 99

0 25 50 100
SCALE IN FEET

NOTE: BASE MAP BASED ON SPRING 1986 CONCORD TOWNSHIP W.1/2 S.E.1/4 SEC. 3 T.37N. R.5E. AERIAL PHOTO.

22334TCA
VR010494

FIGURE 6

RELATIVE RESPONSE TRICHLOROETHANE (TCA)

SELMER COMPANY
500 INDUSTRIAL PARKWAY
ELKHART, INDIANA

JANUARY, 1994

22334

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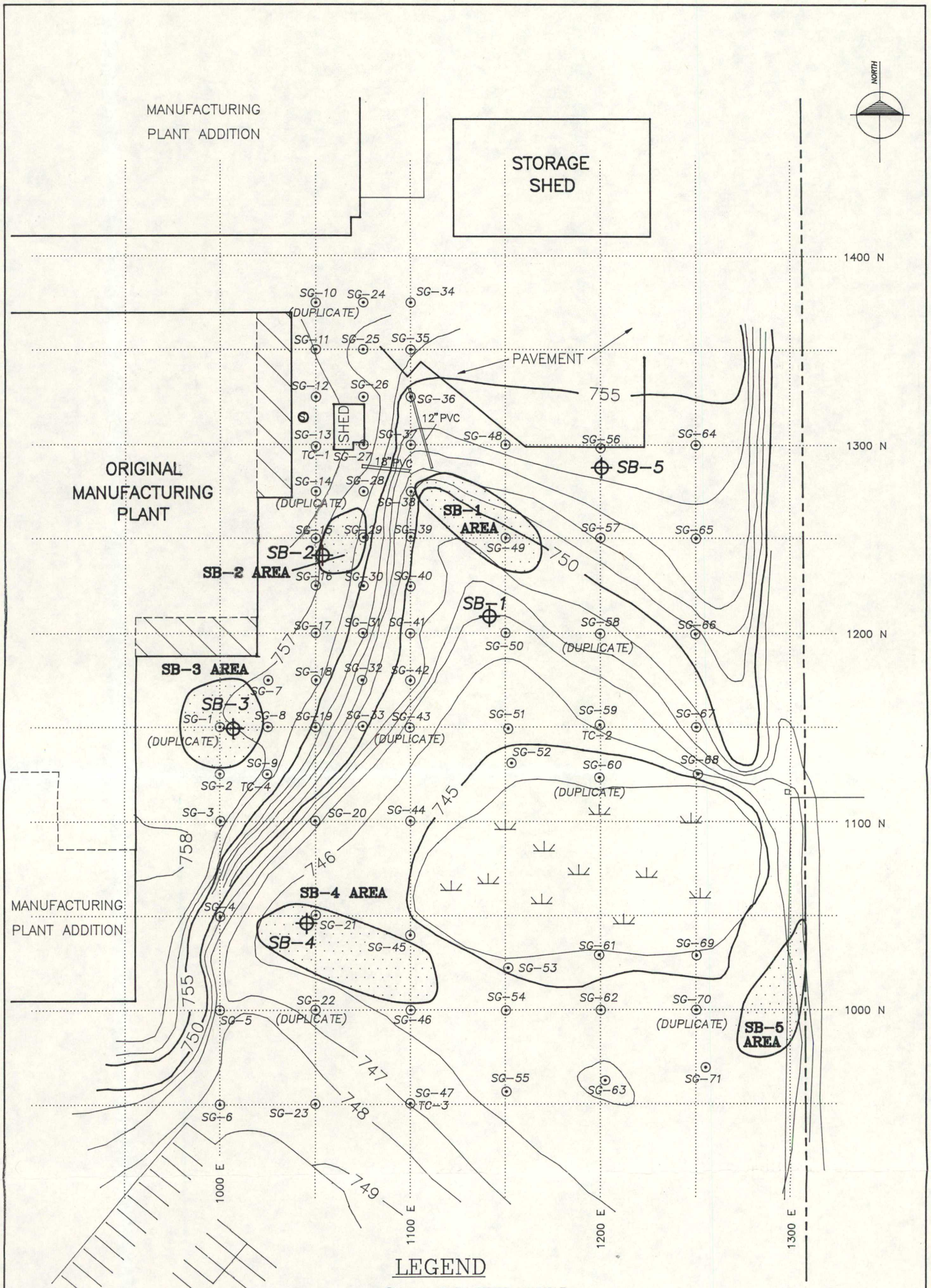

LEGEND

- SANITARY SEWER MANHOLE
- ORIGINALLY PROPOSED SOIL BORING LOCATION IN OCTOBER 1992 WORK PLAN
- PROPERTY BOUNDARY
- SB-1 – PROPOSED SOIL BORING LOCATION
- SG-55 – SOIL GAS SAMPLE LOCATION
- 755 – TOPOGRAPHIC CONTOUR LINE CONTOUR INTERVAL = 1 FOOT

0 25 50 100
SCALE IN FEET

NOTE: BASE MAP BASED ON SPRING 1986 CONCORD TOWNSHIP W.1/2 S.E.1/4 SEC. 3 T.37N. R.5E. AERIAL PHOTO.

22334PSB
VR010594

FIGURE 7
PROPOSED SOIL BORING LOCATION MAP
SELMER COMPANY
500 INDUSTRIAL PARKWAY
ELKHART, INDIANA

JANUARY, 1994 22334

WW Engineering & Science

APPENDIX A

PETREX© Standard Operating Procedures

STANDARD OPERATING PROCEDURES

FOR PETREX

ENVIRONMENTAL SOIL GAS SURVEYS

Revised March 1992

STANDARD OPERATING PROCEDURES FOR PETREX
ENVIRONMENTAL SOIL GAS SURVEYS

1.0 OPENING STATEMENT CONCERNING THE PURPOSE OF THIS DOCUMENT

The steps and information contained herein are the "Standard Procedures" for carrying out a PETREX soil gas survey. Minor alterations from these standard procedures may be implemented onsite by our field staff to adjust for unique survey conditions, such as frozen ground. The PETREX Technique is also used for oil and gas, geothermal, and mineral exploration; slight alterations in the operating procedures may be required for these specialized projects.

If any questions arise upon review of this document, please address your questions to NERI's technical staff. Please call:

Northeast Research Institute, Inc. (203) 677-9666
309 Farmington Avenue, Suite A-100, Farmington, Connecticut 06032

-or-

Northeast Research Institute, Inc. (303) 238-0090
605 Parfet Street, Suite 100, Lakewood, Colorado 80215

2.0 SAMPLER PRODUCTION

2.1 Charcoal Bonding

PETREX collector wires are prepared by applying pre-sieved activated charcoal to the tips of ferromagnetic wires. Details of the procedure for preparing and bonding the activated charcoal are proprietary information. The resultant collector wires contain size-sorted activated charcoal bonded to the area within 1 cm of the tip. The specialty wires selected for this process have a Curie point of 358°C.

2.2 Sampler Tubes

Commercially available glass culture tubes, measuring 25 mm X 125 mm and having a screw cap closure, are prepared by washing in a biodegradable detergent, then rinsed in methanol and baked in an oven at 180°C for one hour.

2.3 Cleaning of Collector Wires

The charcoal bonded ferromagnetic wires are cleaned by heating in a special high vacuum apparatus at 358°C a total of 35 times. Wires are cleaned in lots of 32. From each lot, two wires are removed for immediate analysis by mass spectrometry to verify the cleanliness of the lot. The remaining 30 wires are then sealed in one clean culture tube under an inert atmosphere, assigned a lot number, and the lot(s) placed in inventory.

2.4 Lot Release and Repackaging

2.4.1 Quality Control and Quality Assurance

Prior to releasing inventory lots for a field survey, two collection wires from each lot are tested for cleanliness and adsorption potential. One wire is analyzed by mass spectrometry without exposure ("as is"), to verify that the lot is clean. The second wire is exposed to hexane vapor for two seconds, and then analyzed in order to verify that the charcoal is highly adsorptive.

2.4.2 Repacking for Shipment to the Field

Prior to shipment to the field, approved lots are removed from inventory, and the collector wires are repackaged in pre-cleaned sampler tubes under an inert atmosphere. From each lot containing 30 collector wires, 12 sampler tubes are packaged with 2 collector wires, and 2 sampler tubes with 3 collector wires. (The basis for having 2 wires in a tube is that it allows NERI to analyze one wire by standard Thermal Desorption-Mass Spectrometry (TD-MS), with the second wire being retained as a back-up or used later on for analysis by Thermal-Desorption-Gas Chromatography/Mass Spectrometry (TD-GC/MS). Sampler tubes containing 3 collector wires are used for the mass spectrometer set-up and gain adjustment procedure that is performed for each survey.)

2.5 Custody Document

A "custody document" accompanies each lot(s) of samplers released to the field for a project. This document accompanies the samplers through all transportation, field, and analysis steps.

3.0 FIELD OPERATIONS

3.1 Locating Sampler Sites

Sampler placement sites, usually predetermined on an accepted survey proposal, are located from a nearby, surveyable landmark using a compass and pacing, or some other measuring device (e.g., pacing wheel, hip chain, or tape measure). A transit may be used for more accurate placement, but such accuracy is seldom required.

3.2 Soil Coring

Once a sampler site has been established, a hole is cored to a predetermined depth; sampler placement depth is usually held constant for a given survey. A variety of tools is used for coring, depending on the nature of the surface cover and soil types. The holes should be vertical and as free from debris as possible. For grass covered sites, a coring shovel or core tube with a sledge hammer is used. When a survey is performed in areas covered by asphalt or concrete, a generator-powered rotary hammer drill with a carbide-tipped bit is used to drill a 1-1/2 inch diameter hole in the cover.

Down hole tools are decontaminated between each boring by following the procedure outlined in Section 3.9.

3.3 Sampler Placement

Immediately after the hole is cored, a sampler tube is removed from the Ziploc bag and the bag is resealed. The cap is then removed from the tube, and the tube is placed vertically, open end down, into the hole. The hole is then backfilled with the soil core which was removed. The cap is placed in a clean Ziploc bag to be used again later during sampler retrieval.

Samplers placed under asphalt or concrete are treated the same as those in uncovered soil, except for modifications to permit easy retrieval. To allow retrieval of these samplers, a length of galvanized steel wire is twisted around the neck of the tube and run to the surface so that the tube may be recovered by pulling on the retrieval wire. An aluminum plug is then placed near the top of the hole, and the remainder of the hole is plugged with quick setting hydraulic cement.

3.4 Sampler Location Marking

Each sampler location position is flagged using pin flags, spray paint or ribbon flagging, then the location is marked and numbered on a base map. A field notebook is used to record the date, sampler number, sampler location description, soil type, and general observations.

3.5 Residence Time

"Time calibration" samplers are included as part of every survey. These samplers are placed in a areas ranging from known or suspected contamination to background. Sets are retrieved and analyzed at specified time intervals to determine the appropriate field residence time for the survey. "Travel blank" samplers are also included to monitor for potential contamination acquired during transit. These samplers are transported along with the survey samplers, but the blanks are not opened until they are analyzed in the laboratory.

3.6 Survey Retrieval

All samplers from a survey are retrieved when analysis of the time calibration samplers indicates that there has been sufficient loading of gases onto the charcoal absorbent. The steps in the retrieval process are as follows: (1) Soil is gently excavated until the tube is exposed. (2) A cap is taken from the sealed Ziploc bag. The Viton seal is checked to make sure it is seated inside the cap. (3) The sampler is removed from the hole, and any dirt that is on the threads of the tube is wiped off with a clean cloth. If the tube is broken or cracked, the collection wires are transferred to a new tube using forceps. (4) The tube is capped tightly, numbered (see Section 3.7), and placed in a Ziploc bag. (5) Bore holes are filled or patched as required. (6) Flagging material and any other debris are removed from the survey area.

3.7 Sampler Numbering

Each sampler is immediately numbered according to the scheme established in the field notes and on the base map. The location number is written on an adhesive label which is then applied to the tube cap. In practice, labels are normally pre-numbered before starting the survey retrieval process, to ensure that no two sampler locations have the same number.

3.8 Sampler Shipment

Once all samplers have been retrieved, they are sealed in Ziploc bags, wrapped in bubble packing material, and packed tightly in a box for shipment. (Packing materials such as Styrofoam, vermiculite, or newspaper can introduce contaminants, and therefore should not be used for packaging.) The samplers, field notes, base map, and chain-of-custody document are either hand-carried back to NERI's laboratory or shipped by overnight courier service.

3.9 Decontamination

All down-hole equipment and tool parts which contact contaminated soil are constructed of heavy gauge steel. These tools are decontaminated between use at each sampling location by rotation through a four step cleaning process. The steps are:

1. Immersion and vigorous scrubbing in a mild solution of laboratory grade detergent until all visual accumulations of soil are removed.

2. Thorough rinsing with potable water.

3. Spray rinsing with methyl alcohol.

4. Air drying.

All derived liquids (and sediment) are contained in dedicated disposable vessels.

4.0 SAMPLER ANALYSIS

4.1 Numbering Check

Upon receipt of the samplers in NERI's laboratory, the number on each tube is recorded and any missing or duplicated numbers are noted. A missing number generally indicates that the sampler could not be retrieved. Samplers with identical numbers generally cannot be used unless their true site location can be established.

4.2 Holding Time

Exposed PETREX soil gas collection wires contain a minute quantity of various volatile organic compounds sorbed onto activated charcoal; the protective glass tube is effectively sealed when the Viton-lined cap is seated properly. Maximum holding time is a function of both the chemical stability of the sorbed compounds, and the integrity of the seal on the tube.

It has been our experience that PETREX soil gas samplers that are properly packaged after retrieval from the field, and stored under environmentally controlled conditions, typically remain compositionally unchanged for at least four months. Even with this long term stability, it is NERI's practice to analyze all samplers within three weeks of retrieval from the field.

4.3 Instrumentation

Thermal desorption is accomplished using a Fisher radio frequency power supply and a Curie point pyrolyzer designed by NERI and Extrel. The mass spectrometer used is an Extrel Spectrel quadrupole mass spectrometer. The analysis is controlled and recorded by DEC PDP 11/23 microcomputer. Following the analysis, all data are collected and archived on a personal computer (PC). Data for all active jobs are stored on personal computers, as well as on floppy disks. Data for all completed jobs are stored on magnetic tape and floppy disks in perpetuity.

4.4 Calibration

An Extranuclear Quadrupole Spectrometer equipped with a Curie-point pyrolysis/thermal desorption inlet is used for sampler analysis. Mass assignment and resolution are manually adjusted using a Perfluorotributylamine (PFTBA) standard. A linear correction, based on the known spectrum of PFTBA, is calculated. This correction is applied to a second PFTBA spectrum. If correct mass (M/Z) values are obtained, the operator proceeds to the next turning step. If not, Step 1 is repeated until correct masses are obtained.

Peak intensity ratios are set from the major peaks in the PFTBA spectrum using the following values:

Mass (M/Z)		Spectrum Intensities
69	=	100%
131	=	25%±5%
219	=	35%±5%
502	=	5%±2%

The ion signal for mass (M/Z) 69 of PFTBA is measured at a preset sample pressure and detector voltage and compared to previous values at the same setting.

Electron energy is set to 70 electron volts and emission is set at 12 milliseconds. All other operating parameters, such as scans, scan range, mass offset are established in the computer program. These values may only be changed by the laboratory manager.

Tuning is performed at the beginning of a run, so that a complete survey is analyzed using the same instrument settings. Samplers are analyzed in random order.

4.5 Instrument Parameters

The instrument is operated with the following parameters:

Vacuum	-	$< 3 \times 10^{-6}$ torr
Ionization Energy	-	70.0 eV
Ionization Current	-	12.0 mA
Desorption Time	-	5.0 sec
Desorption Temperature	-	358°C
Number of Scans/Sample	-	30
Scan Rate	-	1,250 amu/sec

4.6 Mass Spectrometer Analysis and QA/QC

Survey samplers are analyzed in random order. All samplers from one survey are analyzed without interruption from other projects.

The organic gases adsorbed onto the charcoal are thermally desorbed, separated according to ion mass, counted, and a mass spectrum of masses from 29 to 240 is obtained.

Periodic (approximately every 20 samples) machine background analyses are performed as a QC measure to assure minimal influence from internal communication. If there are peaks that are not related to atmospheric gases, the supervisor is notified and the mass spectrometer is shut down and cleaned as necessary.

A written sample number record is kept during the analysis to prevent accidental cross numbering. The mass spectrometer control program prompts the operator with a warning if a sample number is entered that has already been used. The operator then checks the current number, along with the disk storage location of the previously entered number, to resolve the true numbering situation.

4.7 Data Filing

The raw data file generated by each analysis is given a unique file name for storage.

4.8 Maintenance

Frequency	Activity
1,000 Analyses	Cleaning of sample introduction area, ion source, and expansion chamber by in-house technicians.
4,000 Analyses	Above noted procedures plus cleaning of lenses and quadrupoles.
Annually:	Preventative maintenance program conducted by manufacturer's service representative.

5.0 DATA INTERPRETATION AND PRESENTATION

5.1 Compound Identification

Individual compounds are identified by comparing the mass spectrum that is obtained from each analysis to a library of reference mass spectra. Several thousand pure compound spectra have been developed by the Bureau of Standards and are available for spectral comparison. NERI has also developed its own library of spectra through headspace analysis of pure compounds using the PETREX process. Once a compound has been identified in this manner, the ion current (or ion count) of this compound is defined as the total ion current for the "parent peak" or the least interfered with peak of that compound. In a typical PETREX survey, numerous compounds are identified from each analysis.

5.2 Compound Mapping

5.2.1 Production of Sampler Location Map

Sampler location maps are created by placing the field base map on a digitizing board and entering each sampler location (and its respective number) as an X-Y coordinate relative to an origin. Alternatively, base maps may be supplied by the client in various CAD output formats on a floppy disk. Cultural and topographic features can also be digitized onto the map as reference points. The relative ion current (or ion count) for each compound can then be plotted at the exact sampler locations.

5.2.2 Production of PETREX Isopleth Maps

The process of plotting total ion counts of indicator peaks from the compound(s) identified in the soil gas survey is computerized. Thus the summed ion counts from indicator peaks of identified compound(s) are matched with the sampler location on the base map, and the numeric value is plotted. The data are then contoured to take into account all other available data, such as geologic setting, soil types, groundwater conditions, type of contaminant, and site history.

The resultant maps show, per compound or class of compounds, isopleth lines that define the relative intensity of the signal throughout the survey area. Soil gas isopleth maps are useful for interpreting the areal extent of contamination, the location of source areas and relative "hot spots", and the direction of movement of the contaminants.

The entire PETREX process permits the collection, identification and mapping of numerous compounds simultaneously. This information is used to differentiate multiple compounds and multiple source areas within a single survey.

5.3 Guidance on the Interpretation of Soil Gas Results

Confirmation and quantification of soil gas results are generally conducted using standard field sampling methods for soil and groundwater analysis. The soil gas maps are used to guide the placement of borings and wells.

In general, extreme caution needs to be exercised when trying to extrapolate soil gas results (without the above sampling and analysis) to predict exact source of the soil gas signal (i.e. soil or groundwater), the depth of the signal, or concentrations of contaminants. In NERI's experience, the following hold true:

Results from soil gas surveys that have been conducted at a uniform shallow depth <u>cannot</u> be used to calculate the depth to the source or the concentration of contaminants at depth. Depth profiling (see Section 5.5.2) can greatly enhance the interpretation of the survey results.

Ion counts for any compound at one sample location can only be compared to another location within the same survey for the same compound. Ion counts of different compounds cannot be compared to each other. Also, the isopleth maps from one survey cannot be quantitatively compared to the results of any other survey, or between two surveys conducted at the same site at different times of the year. However, the same "hot spots" and migration pathways normally are detected in the same place over multiple surveys at a given site, allowing for migration.

5.4 Data Presentation

Once the data have been compiled, interpreted, and mapped, a report is produced for the client's use. Also, isopleth maps are finalized and printed using a sophisticated plotter and CAD software. These reports and maps are for the client's use only, and no report or map is released to anyone else without prior written consent of the client.

6.0 Additional Uses of PETREX SAMPLERS

PETREX samplers have numerous other uses, and the techniques described below are often incorporated into the soil gas survey design. (Specific instructions on sampling, shipment methods, and blanks are provided for each project.)

6.1 Headspace Analysis of Soils and Water

Headspace analysis can be used to establish a mass spectrometric pattern of compounds from soils or water; this pattern can then be used during interpretation of the soil gas survey by searching for the headspace pattern in the results obtained from the soil gas survey. This approach is very helpful for verifying sources or for mapping specific blends of commercial products at a site.

A soil sample is headspaced by collecting approximately 25 grams of soil in a thermochemically cleaned headspace container. A clean PETREX culture tube is often used. The sample is shipped to NERI's laboratory, where several PETREX collection wires are added. The sample is allowed to equilibrate for up to 24 hours, depending on the level of contamination. The exposed wires are then removed and prepared for thermal desorption mass spectrometric analysis as described earlier. A similar process is used for screening water samples.

6.2 Depth Profiling

In order to determine if the source of the soil gas signal is near surface or in a deeper vadose/saturated zone, depth profiling can be used.

At each selected location, shallow bore holes are drilled a few feet apart to depths such as 1, 2, 4, and 6 feet deep. After all the loose cuttings and cavings have been removed from the bottom of the hole, a core of soil may be taken for headspace analysis. Next, a PETREX Sampler is installed as described earlier. The samplers remain in place for the same length of time as the rest of the PETREX survey.

Each of the PETREX sampling methods addresses different questions concerning the source of the VOC signal as detected during a soil gas survey.

In the case of soil headspace analysis, detection of VOCs indicates that the VOCs are actually contained within the soil matrix. When the VOC is anthropogenic in nature, the VOC presence is indicative of soil contamination at that depth interval.

When performing passive soil gas sampling with PETREX samplers, the sampler serves as both an extended headspace sampler relative to the soil matrix in its immediate vicinity, as well as measuring the relative rate of soil gas movement through that zone during the exposure period.

Soil gas movement through the vadose zone is theorized to be a diffusion process. If the soil headspace data indicate that the VOC is not present in the soil matrix, then the depth profiling samplers should show a relative increase of ion counts as the depth increases. By combining results from depth profiling and headspace analyses, the nature of the VOC source (near surface or deep vadose/saturated) can be inferred.

-END-

APPENDIX B

NERI Report of Findings

FINAL REPORT
ON THE FINDINGS OF THE PETREX SOIL GAS SURVEY PERFORMED AT THE SELMER SITE IN ELKHART, INDIANA

PREPARED FOR:
W.W. ENGINEERING AND SCIENCE

PREPARED BY: **DATE:**

Nancy F. Gaines 12/13/93

NANCY F. GAINES
FIELD GEOLOGIST

APPROVED BY: **DATE:**

Mark H. Hatheway 12/13/93

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MANAGER OF ENVIRONMENTAL OPERATIONS

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DECEMBER 13, 1993

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1.0 EXECUTIVE SUMMARY

In November 1993, W.W. Engineering and Science (WWES) conducted a PETREX passive soil gas survey at the Selmer site in Elkhart, Indiana. The survey was conducted in an area east of the manufacturing building where improper disposal of trichloroethene (TCE) was alleged to have occurred in the past. The purpose of the survey was to identify the presence of volatile organic compounds (VOCs) in the soil gas. The survey results indicate the presence of tetrachloroethene (PCE) and TCE in the soil gas along the eastern side of the manufacturing plant. Trichloroethane (TCA) was also detected at moderate levels in several localized portions of the survey area.

2.0 INTRODUCTION

W.W. Engineering and Science (WWES) conducted a PETREX passive soil gas survey at the Selmer site in Elkhart, Indiana utilizing samplers provided by Northeast Research Institute (NERI). The purpose of this survey was to determine the presence of volatile organic compounds (VOCs), including chlorinated solvents, in the soil gas and to identify areas of high response in the area east of the manufacturing building.

3.0 OBJECTIVES

The objectives of NERI's portion of this soil gas survey were to:

1. Identify and report VOCs which may be present in the soil gas at the site; and

2. Map the areal distribution of the reported compounds.

4.0 OVERVIEW OF THE PETREX TECHNIQUE

Each PETREX soil gas sampler consists of two or three activated charcoal adsorption elements (collectors) housed in a resealable glass container in an inert atmosphere. The soil gas collector is a metallic wire, having specific ferromagnetic characteristics, to the end of which is bonded a discrete amount of activated charcoal.

Soil gas sample collection is performed by unsealing the sampler and exposing the collector to the soil gas of the subsurface environment at the base of a shallow borehole. Sample collection proceeds via free vapor diffusion through the opening of the uncapped sampler container. Following a controlled period of time, the sampler is retrieved from the borehole, resealed, and submitted for analysis.

Analysis of one collector from each soil gas sample is performed via Thermal Desorption/Mass Spectrometry (TD-MS) and yields data in the form of a numerical file categorizing by molecular weight the relative abundance of chemical compounds collected by each sampler. This information is graphically represented as a mass spectrum. Data on a particular compound or class of compounds are further presented in reference to a sample number and sample collection point on a scaled site plan. The second collector may be analyzed by Thermal Desorption-Gas Chromatography/Mass Spectrometry (TD-GC/MS) for compound confirmation. The third collector is used for setting instrument sensitivity prior to commencement of analysis. At least ten percent of the samplers used in any project contain three collector samplers.

Compounds are identified by comparison to standard reference spectra run on the same instrument. The relative response of the appropriate indicator peak(s) for each compound or group of compounds is then plotted on a map and contoured.

5.0 SURVEY DESIGN

A total of 71 PETREX soil gas samplers (SG-1 through SG-71) were utilized for this survey. The samplers were placed in a 50-foot square grid in the lowland area east of the manufacturing building and in a 25-foot square grid near the manufacturing plant. WWES designed and implemented the survey layout as approved by the U.S. EPA.

6.0 FIELD ACTIVITIES

All field work was conducted by WWES personnel previously trained in PETREX field methods. A description of typical PETREX field methods is provided in Appendix A, PETREX Protocol.

6.1 Sampler Installation and Retrieval

On November 1 and 2, 1993, WWES installed the PETREX soil gas samplers at the site (Plate 1). Time calibration samplers (TC-1 through TC-4) were installed at four sample locations (SG-9, SG-13, SG-47, and SG-59). One set of samplers was retrieved after three days and the other set after seven days of exposure in the field. These samplers were analyzed to determine the most appropriate sampler field exposure time. After reviewing the results from the time calibration samplers, it was determined to retrieve the survey samplers after approximately 11 days of exposure in the field.

On November 12, 1993, after an exposure period of 11 days, WWES personnel retrieved all of the survey samplers. The samplers were shipped via overnight courier on November 15, 1993 to NERI's Lakewood, Colorado laboratory for analysis by Thermal Desorption-Mass Spectrometry (TD-MS).

7.0 METHOD QA/QC

A description of the PETREX QA/QC procedures is provided in Appendix A, PETREX Protocol.

7.1 Travel Blanks

Two PETREX samplers, which remained sealed, traveled with the survey samplers to the field and back to the laboratory. These two travel blanks were analyzed concurrently with the survey samplers. Results of analysis of the travel blanks showed only normal atmospheric compounds and instrument noise. TCA was detected at low levels, at several orders of magnitude lower than the high and moderate response zones shown on Plate 4, Appendix D. Table 1, Appendix C lists the relative responses of the mapped compounds from the travel blanks.

8.0 RESULTS

All samplers were analyzed by NERI's standard method of Thermal Desorption/Mass Spectrometry (TD-MS). Tetrachloroethene (PCE), trichloroethene (TCE), and trichloroethane (TCA) were found to be the most prominent compounds in the soil gas at this site. Other compounds were detected at levels indicative of normal atmospheric conditions. In order to map the reported compounds, mass spectral peaks indicative of the compounds were selected and their corresponding ion counts were plotted. Table 2 lists the reported compounds and their selected indicator mass peaks in atomic mass units (AMUs).

TABLE 2

Reported Compounds and Their Indicator Mass Peaks

Reported Compound	Indicator Mass Peak(s) (AMU)
PCE	164
TCE	130
TCA	101

Exemplary mass spectra are provided in Appendix B. The results are tabulated in Appendix C and are summarized on the plates listed below, which are located in Appendix D.

Plate 1: Sample Locations Map
Plate 2: Tetrachloroethene (PCE) Relative Response Map
Plate 3: Trichloroethene (TCE) Relative Response Map
Plate 4: Trichloroethane (TCA) Relative Response Map

9.0 DISCUSSION

The soil gas response levels discussed in the following section are described as elevated and moderate relative to the entire data set. The ion count values that have been reported represent qualitative soil gas values that were evaluated relative to the other sampler locations.

Ion count values are the unit of measure generated by the mass spectrometer to illustrate the relative intensities associated with each of the reported compounds. These response levels do not represent an actual concentration of the reported compounds but are used to differentiate source areas from migration/dispersion pathways.

For a complete discussion of relative response map evaluation, please refer to the PETREX Protocol, Appendix A.

9.1 Tetrachloroethene (PCE) Relative Response Map

Plate 2 represents the survey response for the presence of PCE in the soil gas. Areas of higher response appear along western portions of the survey area near the manufacturing plant. An area of moderate response appeared in the northeast corner of the survey area.

9.2 Trichloroethene (TCE) Relative Response Map

Plate 3 represents the survey response for the presence of TCE in the soil gas. Areas of higher response appear along the western edge of the survey area (near the manufacturing building).

9.3 Trichloroethane (TCA) Relative Response Map

Plate 4 represents the survey response for the presence of TCA in the soil gas. Several small areas of moderate response appeared, primarily in the northwestern portion of the survey area.

10.0 Conclusions

PCE, TCE, and TCA are present in the soil gas along the western portion of the survey area (near the manufacturing building).

11.0 Notice

In connection with this survey and associated interpretation, only a limited scope of work was performed by NERI. Therefore, NERI maintains that it has not defined the scope of the environmental condition of the site. Professional judgements made within the context of this report are based on technical data made available to NERI. NERI assumes no responsibility for conditions which did not come to its actual knowledge, or conditions not generally recognized as environmentally unacceptable at the time this report was prepared. Furthermore, NERI assumes no responsibility for actions taken in response to the release of these findings.

APPENDIX A
PETREX PROTOCOL

APPENDIX B
EXEMPLARY MASS SPECTRA

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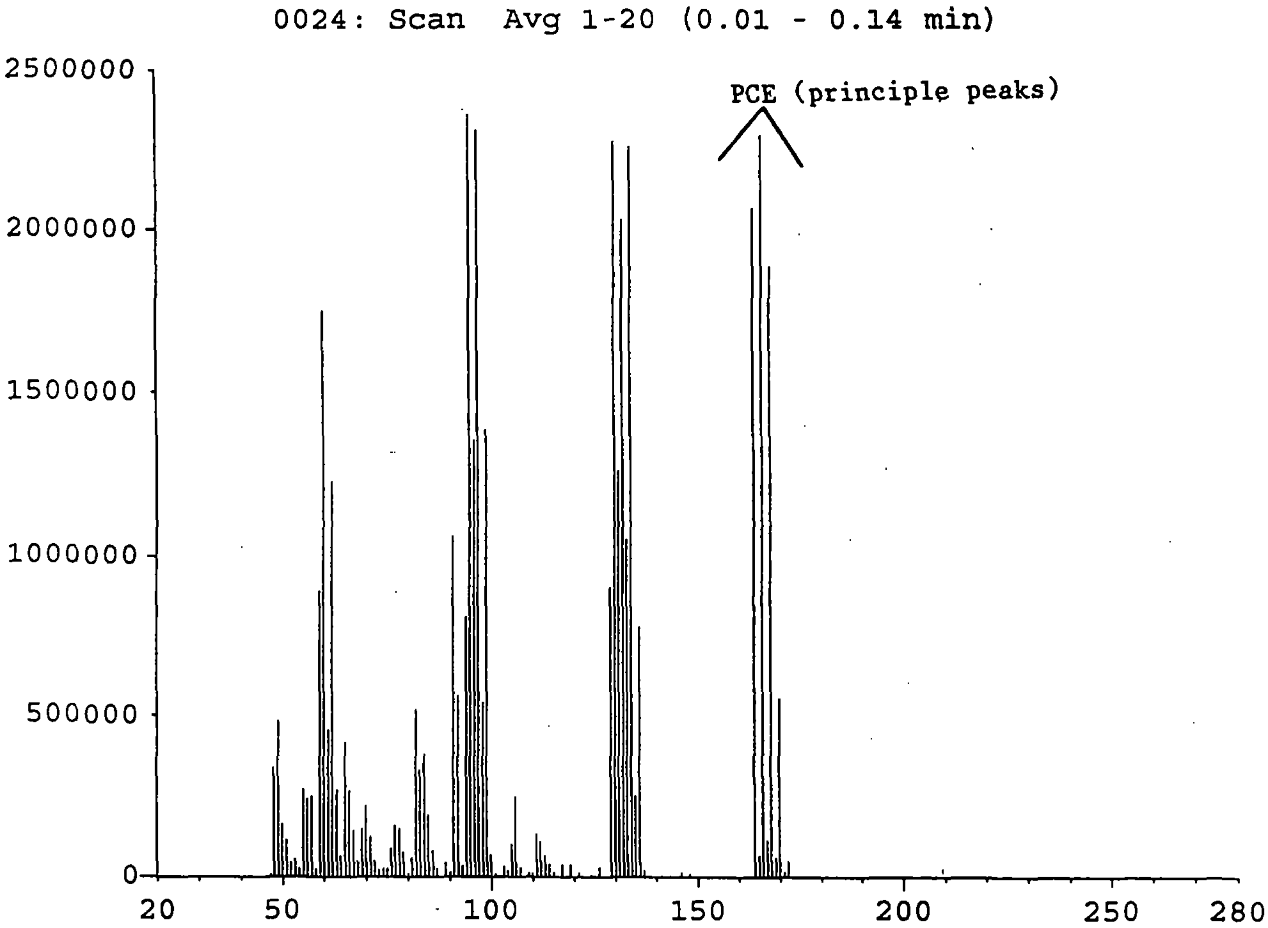
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PCE (principle peaks)
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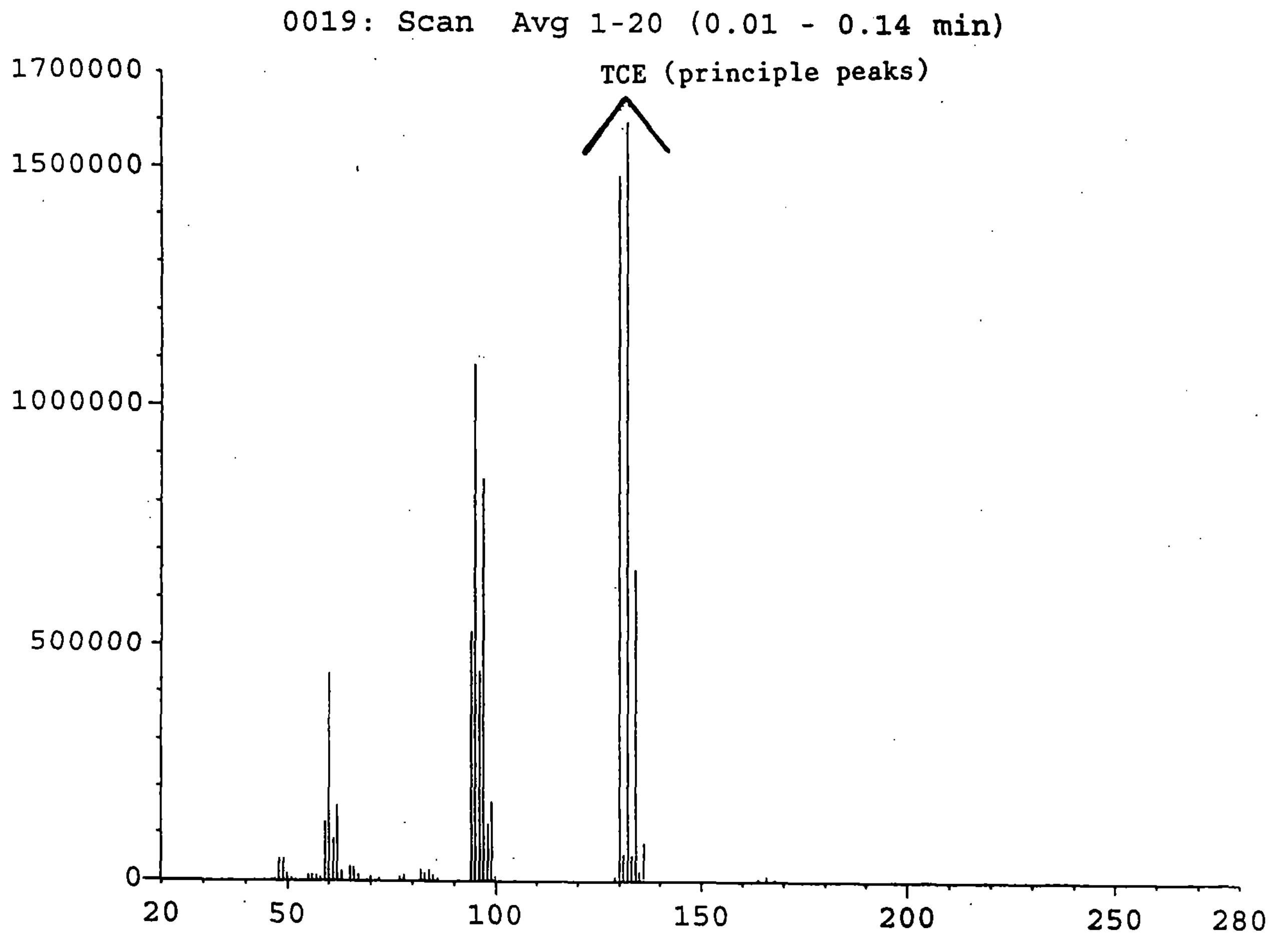
2000000
1500000
1000000
500000
0
20
50
100
150
200
250
280

1987 · 1



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TCE (principle peaks)
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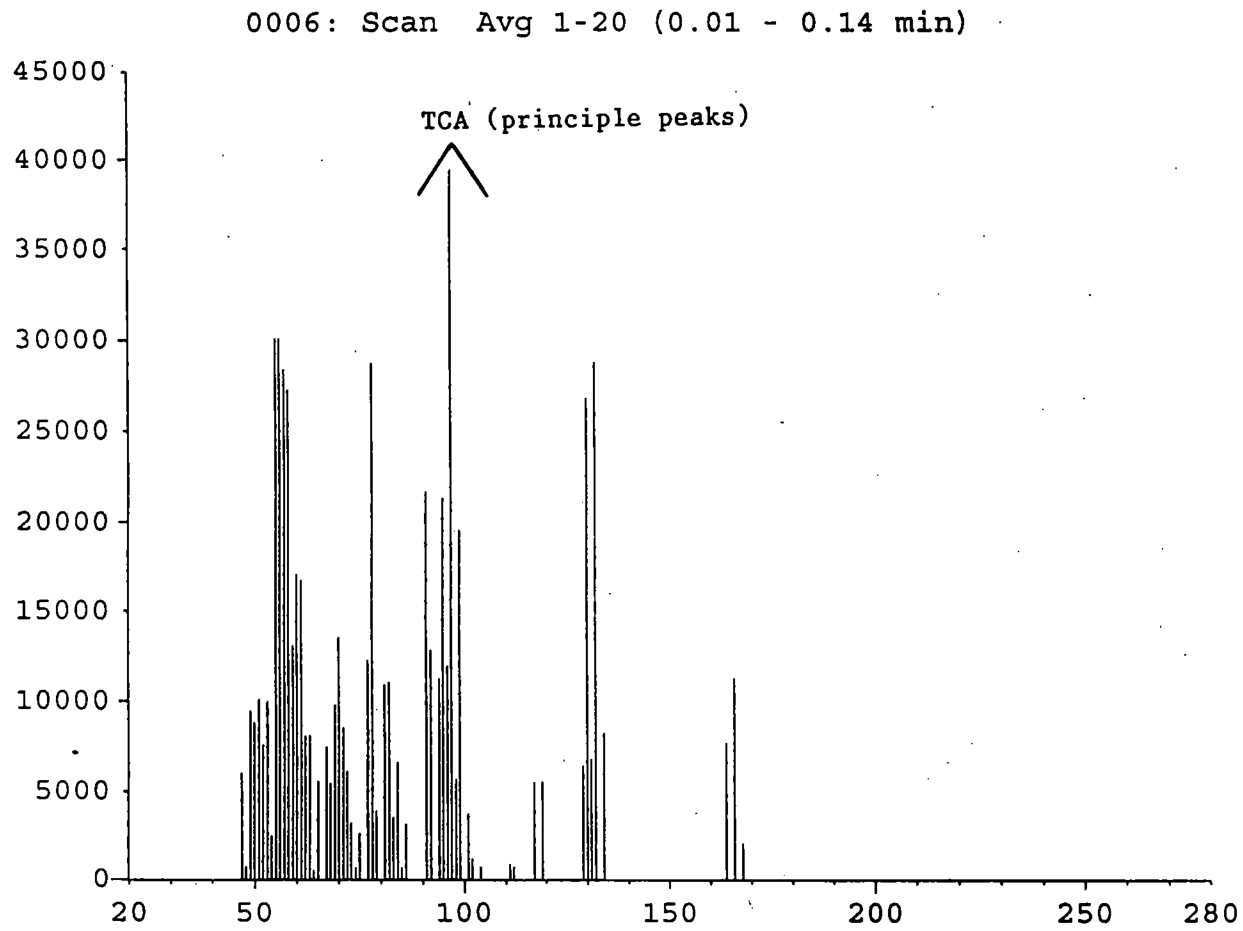
1500000
1000000
500000
0
20
50
100
150
200
250
280

1987·1



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TCA (principle peaks)
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40000
35000
30000
25000
20000
15000
10000
5000
0
20
50
100
150
200
250
280

APPENDIX C
TABULAR RESULTS FOR THE TRAVEL BLANKS AND SURVEY SAMPLERS

Table 1
For the Petrex Soil Gas Survey
Conducted at the Selmer Site
in Elkhart, Indiana
by W.W. Engineering and Science. Inc.
November 29, 1993

(all values below are in units of ion counts, and are divided by 1,000)

Sample Number	PCE	TCE	TCA
1	2170	2608	27
2	1735	3129	11
3	11	1222	ND
4	51	911	3
5	41	114	6
6	8	27	4
7	553	1980	11
8	1308	1907	7
9	66	1988	7
10	633	2445	5
11	2615	2436	42
12	1267	2400	10
13	1050	2479	5
14	466	1514	ND
15	51	3237	1
16	23	3699	1
17	29	1262	4
18	59	2345	37
19	6	1480	2
20	9	78	6
21	ND	26	ND
22	ND	13	1
23	5	179	3
24	2065	2299	8
25	809	2686	4
26	58	1633	3
27	720	3101	38
28	1274	2121	47
29	17	2277	3
30	20	2064	1
31	776	1729	17
32	290	2383	18
33	39	1500	22

Table 1
(continued)

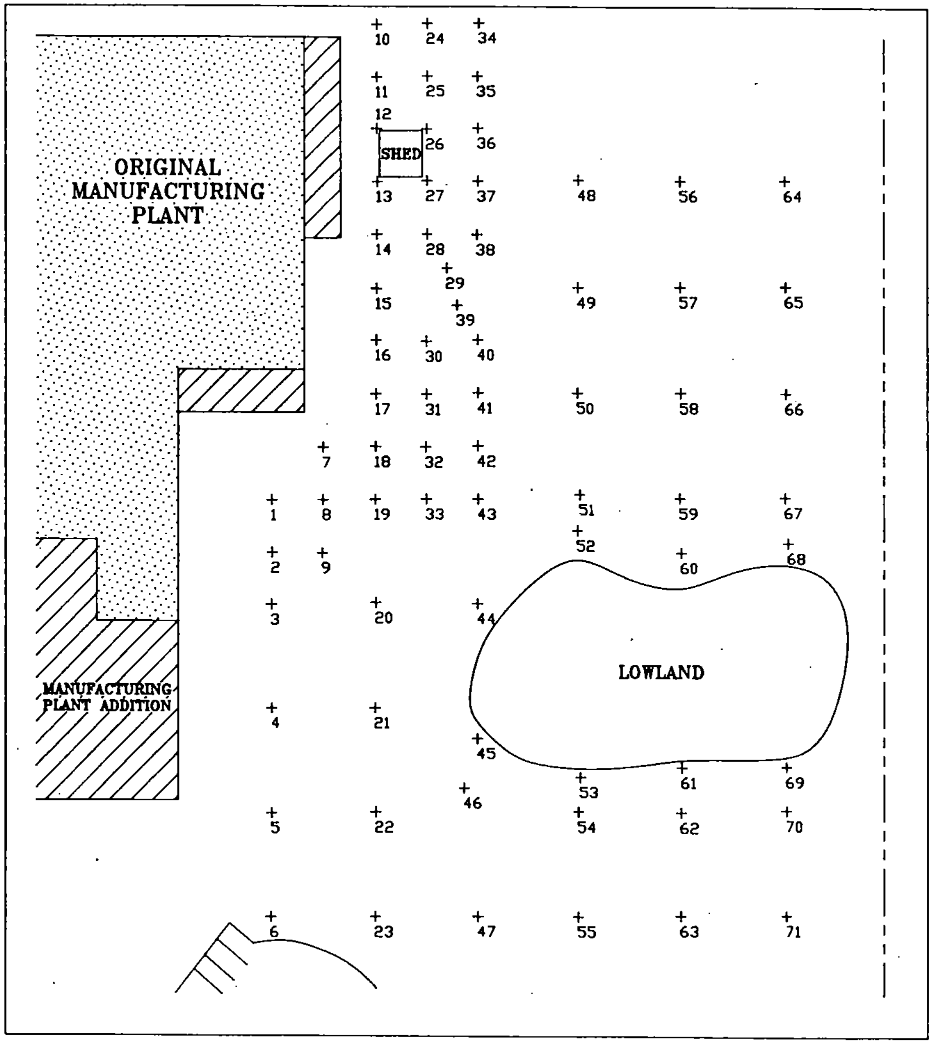
Sample Number	PCE	TCE	TCA
34	1691	3185	8
35	47	1684	42
36	9	1313	ND
37	733	1304	9
38	6	1734	2
39	8	1865	6
40	ND	1214	ND
41	2	666	6
42	1278	335	656
43	4	631	8
44	ND	3	ND
45	ND	11	8
46	ND	10	5
47	1	138	ND
48	2	132	ND
49	13	584	2
50	72	2060	2
51	3	15	ND
52	ND	2	ND
53	ND	ND	2
54	ND	6	4
55	ND	ND	ND
56	677	1168	39
57	234	621	37
58	32	580	5
59	11	150	1
60	ND	ND	2
61	ND	ND	ND
62	ND	3	ND
63	ND	6	2
64	185	932	6
65	2	24	2
66	ND	72	ND
67	17	529	4
68	ND	1	2
69	ND	7	ND

Table 1
(continued)

Sample Number	**PCE**	**TCE**	**TCA**	
70	7	699	3	
71	312	447	14	
72	ND	ND	7	Travel Blank
73	ND	ND	7	Travel Blank

PCE = Tetrachloroethene
TCE = Trichloroethene
TCA = Trichloroethane
ND = None Detected

APPENDIX D
RELATIVE RESPONSE MAPS, PLATES 1-4



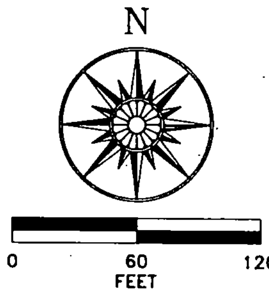
NERI
Northeast Research Institute

309 Farmington Avenue
Suite A-100
Farmington, Connecticut 06032
(203) 677-9666

LEGEND

\+ Petrex Sample Location

— — — — Property Boundary



WW Engineering & Science, Inc.

Sample Locations

Selmer Site
Elkhart, Indiana

Plate 1

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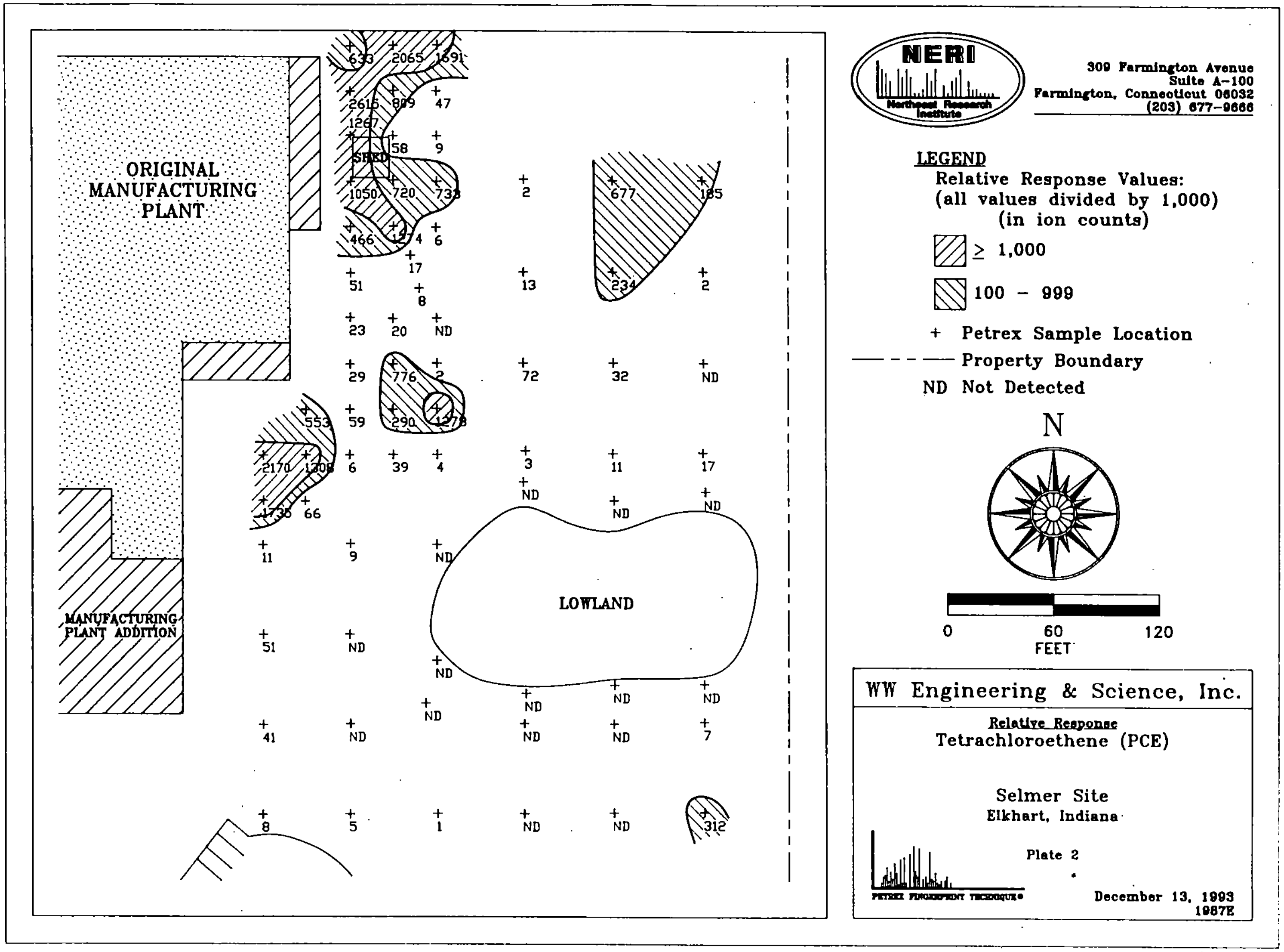
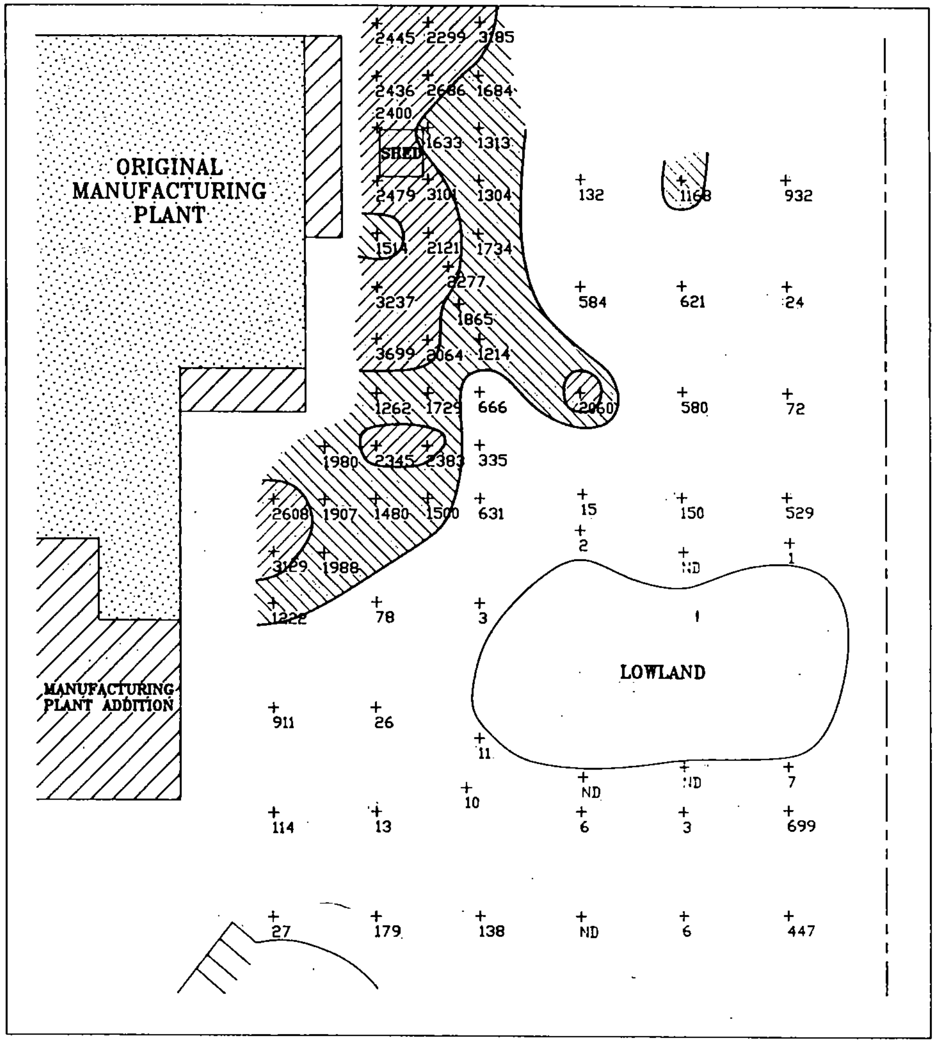
December 13, 1993
1987E



ORIGINAL MANUFACTURING PLANT
MANUFACTURING PLANT ADDITION
SHED
LOWLAND
NERI
Northeast Research Institute
309 Farmington Avenue
Suite A-100
Farmington, Connecticut 06032
(203) 677-9666
LEGEND
Relative Response Values:
(all values divided by 1,000)
(in ion counts)
≥ 1,000
100 - 999
+ Petrex Sample Location
Property Boundary
ND Not Detected
N
0
60
120
FEET
WW Engineering & Science, Inc.
Relative Response
Tetrachloroethene (PCE)
Selmer Site
Elkhart, Indiana
Plate 2
PETREX FINGERPRINT TECHNIQUE®
December 13, 1993
1987E



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Northeast Research Institute
309 Farmington Avenue
Suite A-100
Farmington, Connecticut 06032
(203) 677-9666

LEGEND

Relative Response Values:
(all values divided by 1,000)
(in ion counts)

- $\geq$ 2,000
- 1,000 – 1,999
- + Petrex Sample Location
- — - - — Property Boundary
- ND Not Detected

N

0 60 120
FEET

WW Engineering & Science, Inc.

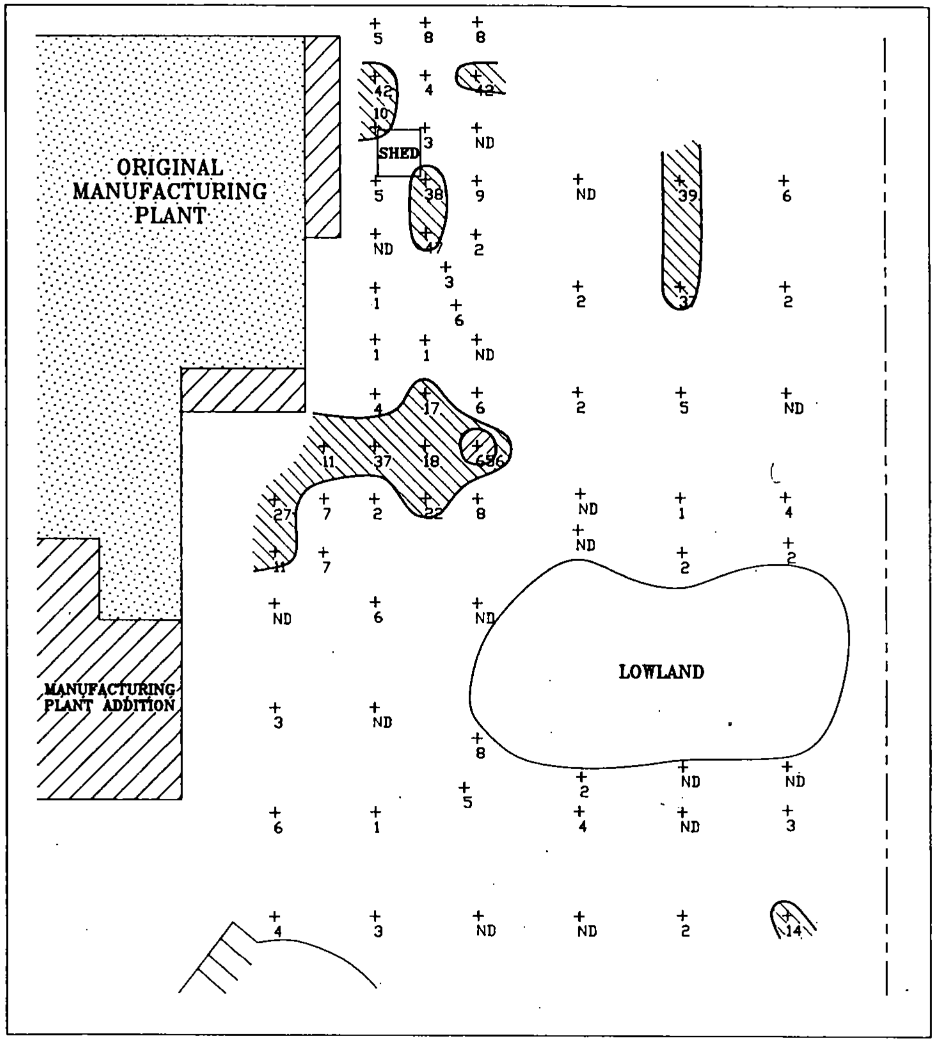
Relative Response
Trichloroethene (TCE)

Selmer Site
Elkhart, Indiana

Plate 3

PETREX FINGERPRINT TECHNIQUE®

December 13, 1993
1987E



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Northeast Research Institute
309 Farmington Avenue
Suite A-100
Farmington, Connecticut 06032
(203) 677-9666

LEGEND
Relative Response Values:
(all values divided by 1,000)
(in ion counts)

≥ 100

10 – 99

+ Petrex Sample Location

— — — Property Boundary

ND Not Detected

N

0 60 120
FEET

WW Engineering & Science, Inc.

Relative Response
Trichloroethane (TCA)

Selmer Site
Elkhart, Indiana

Plate 4

PETREX FINGERPRINT TECHNIQUE®

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